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ABSTRACT

A component of preservice teacher education is the methodology of teaching mathematics using manipulatives. To enhance prospective teachers' understanding of the use of manipulatives to teach mathematics, interactive video can provide an effective medium to bring the reality of the school classroom to the university classroom. Two interactive videodiscs were developed for use in mathematics education courses. The discs contained classroom scenes of teachers and children from three grade levels using manipulatives to develop conceptual understanding of mathematics topics using geoboards and numeration blocks. These discs were integrated into lessons presented to preservice teachers as part of their methods course. The contents of the videodiscs and the way they were used in the lessons were evaluated through interviews with 19 preservice teachers and analyses of their responses on a 7-point scale. Their generally favorable responses will be used to improve disc content and the way discs are used for instruction. (Contains 20 references.) (Author/SLD)

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Interactive Videodiscs, Vignettes, and Manipulatives: A Mix That Enhances the Mathematics Methods Class

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ABSTRACT

A component of preservice teacher education is the methodology of teaching mathematics using manipulatives. To enhance prospective teachers' understanding of the use of manipulatives to teach mathematics, interactive video can provide an effective medium to bring the reality of the school classroom to the university classroom. Two interactive videodiscs were developed to use in mathematics education courses. The discs contained classroom scenes of teachers and children from three grade levels using manipulatives to develop conceptual understanding of mathematics topics using geoboards and numeration blocks. These discs were integrated into lessons presented to preservice teachers as part of their methods course. The contents of the videodiscs and the way they were used in the lessons were evaluated through interviews and response on a 7-point scale. The responses are reported in this article. They will be used to improve the disc content and the way we use the discs for instruction.

"It's sort of like getting experience. How do you teach experience?"

"It makes you a bit more qualified than other people already teaching who don't have experience with them."

"Rather than just learning theory, we saw the material actually being applied in the classroom."

"The videodisc showed that math can be relevant and exciting for children."

Introduction

Research findings (Suydam & Higgins, 1977; Fensler, 1983; Parham, 1983; Akers, 1986; Suydam, 1986; Scott, 1987) indicate that using manipulatives to teach mathematics concepts helps elementary school students improve both their mathematics performance and their attitude toward mathematics. A recent review of 60 studies on manipulative use in mathematics instruction (Sowell, 1989) showed overwhelmingly that manipulative use enhances student learning. These studies generally show (1) that children learn best when they are active participants, (2) that children should be given many opportunities to manipulate physical objects in the study of mathematics, and (3) that manipulatives help children develop mathematical concepts and skills. In addition, there is a strong theoretical foundation for these beliefs in the work of Piaget (1952), Dienes (1960), Gagne (1970) and Skemp (1982). These researchers theorized that manipulatives helped children see the meanings and real-world applications of mathematical concepts.

However, there is a scarcity of research on the factors that contribute to teachers' decisions as to whether they will use manipulatives in their classrooms on an ongoing basis. Ball (1990), Trueblood (1986), and Cooney (1985), among others, call for further research to investigate the influences which determine use or non-use of mathematics manipulatives in the elementary classroom. Hatfield (in preparation) conducted research with former mathematics methods students during their student teaching period

and as a beginning teacher to determine what factors influenced their use of manipulatives for teaching mathematics. During their college methods course, these students received intense instruction on teaching mathematics with manipulatives. These students were followed for two years and data was gathered through interviews and classroom observations. The data indicates that a factor that plays a strong role in determining manipulative use is the students' lack of competence and confidence teaching with manipulatives. An emerging theme from the interview data is the students' request for additional experiences and hours of training in their college mathematics methods course. The reality of the classroom (dominance of paper-pencil tasks, role of competency tests, availability of manipulatives, classroom management issues, lack of mentoring by the cooperating teacher demonstrating how to teach children using manipulatives) is a determining factor in this question of use or non-use of manipulatives for teaching mathematics. The question at the college level becomes how can methods classes provide prospective teachers with the knowledge, attitudes and skills that will make it more likely that they will use manipulatives in their classrooms.

Interactive Video as an Instructional Tool

Instruction based on using the videodisc as a source of images and sounds and using its random access capability has been effective on teaching topics from biology to aircraft simulation (Nelson, 1987). Savenye (1990) has just published a more recent and comprehensive review of research on effectiveness of interactive video use for instruction. She summarizes reviews by Bosco (1986), DeBloois (1988), and Slee (1989). They reviewed research on applications in public schools, higher education, social services, business and industry, and the military. The benefits that were reported for this type of instruction were in achievement, attitude, time for instruction, and performance. The research reports favor interactive video use. Some caution must be used in interpreting the results because many of the reports do not use statistical tests on the outcomes to determine the effect of the treatments in the research. The results are also difficult to interpret because the treatments are not described in detail (Bosco, 1986).

Interactive video is a relatively new approach to delivering instruction. The authors feel that it has potential to assist concept learning, skill development, and attitude change in mathematics

methods courses. It can enhance current instruction and provide extra instruction about manipulatives that beginning teachers say they need. Many questions remain to be answered in order that interactive video and the next generation tools can be used to their full potential. An NFS funded project at Arizona State University is developing videodisc learning environments in order to investigate some of these questions related to mathematics teacher education.

Development of the classroom videotapes and the videodisc.

Since the videodiscs are limited to 30 minutes of video content, an important step was selecting classroom scenes that could be viewed from multiple perspectives. These scenes illustrated many elements of the dynamics of the mathematics classroom. For example, a scene might have grade 3 children working in pairs to solve an area problem using a geoboard. The teacher may be interacting with the children by asking questions, perhaps in Spanish. Other scenes may show grade 1 children working on perimeter tasks as a whole group activity directed by the teacher.

Tasks were selected for classroom use that would show a variety of uses of the geoboard or numeration blocks. These were presented to students in the three grades that were videotaped. For the geoboard disc the tasks included creating shapes with 3, 4, and 5 sides, recognizing shapes, placing shapes on the geoboard, putting a geoband around a posterboard shape placed on the geoboard to form the boundary, designating a shape by the coordinates of its vertices, determining the area of shapes with only right angles and of triangles, and determining the perimeter of these shapes. Tasks for the numeration disc included recognizing and representing numbers, trading games, and using numeration blocks to add, subtract, and divide. The students were presented with these tasks by the teacher or from an instruction sheet. The students engaged in the tasks individually, in pairs or as a whole class. In some scenes the students were working without teacher interaction while in others, the teacher was questioning or guiding the students. Some of the tasks were based on a game format. Some tasks were beyond the ability of the students so we could see how they coped. For example, grade 1 students were asked to find the area of a triangle. In the time allowed, only a small portion of the possible uses of the geoboard and the numeration blocks could be demonstrated. We envision that our preservice teachers will learn of other uses by

reading and exploring with the manipulatives and through computer-based graphical presentations.

From this variety of videotaped tasks and instructional elements, we intended to provide instructors with a generic visual database of vignettes that they could use during their instruction. Another possible use of the database could be by instructional designers to develop videodisc-based instruction. The instructors or designers could support their presentations with disc examples of different types of instructional grouping, different forms of instructional tasks, different uses of manipulatives, development across grade levels, teacher questioning and guiding, and student understandings and misconceptions. Clips were selected for the discs if they were representative of multiple catagories of instructional elements as just listed.

Students and Teachers Participating in the Videotaped Lessons

Students and teachers volunteered to participate in the 2-3 hour taping sessions held on Saturdays. The tasks for the morning involved using numeration blocks and the afternoon tasks involved using geoboards. Different groups of children were used in the two sessions. The most difficult aspect of video work in classrooms is obtaining quality audio and getting close, clear shots of students working. We overcame these by keeping the two cameras stationary and each one focused on two children at a table. One camera could be used to tape the teacher if she/he was talking and not near the students. The students were moved around to ensure that all students were taped at the "camera" tables. The two students viewed by each camera had wireless mikes and were recorded on the respective camera. The teacher also had a wireless mike and was recorded on the camera designated for the teacher. This procedure produced clear audio and images.

The students were presented with the tasks in an appropriate learning sequence. When sufficient video had been obtained or no new behaviors were observed, students were presented with another task. This process continued through all the tasks. We were pleased by the tolerance and cooperation of the students through these hectic events for 2 to 3 hours.

Selecting the Final Video Segments

The final product was about 17 hours of classroom videotape. Also two classes of university students and their mathematics methods instructor were videotaped at the university as they covered mathematical concepts using geoboards and numeration blocks. This produced four more hours of tape. The tape was edited first to remove the technically flawed sequences so we had less to log. This tape was viewed many times and the "richest" clips were selected for the final two discs to give the greatest variety of material with which to work. Each of these clips contained multiple ideas about mathematics teaching and learning. Each 30 minute tape was then recorded onto a videodisc. These two videodiscs have been used in our research to evaluate the effectiveness of using this material in mathematics education methods classes to help preservice teachers to understand how to use geoboards and numeration blocks in instruction. Both a level one and a level three system are being developed and evaluated. This report is about formative evaluation of level one use of the disc during instruction in several classrooms. Because much of the student feedback relates to the content of the disc and its use in instruction, it will help with the development of the level three interactive videodisc instructional system.

The Methods Class Lessons

The videodiscs that we produced have been used during lessons in 2-3 hour mathematics methods classes. The lessons were about using geoboards and numeration blocks, about the concepts and skills that can be developed, and about alternate instructional methods and groupings that can be used in the classroom. It was our intention to show what engaging tasks and classroom interactions could be like when manipulatives are used. Our preservice teachers rarely see extensive use of manipulatives in their observation classrooms as well as in their student teaching classrooms. It was also our intent to help the preservice teachers extend their knowledge of typical school mathematics content. The topics presented in the lessons were area, perimeter, numeration, and basic number algorithms. The lesson was developed and clips from the videodisc were selected to support certain elements of the lesson as appropriate. The lessons involved the preservice teachers in working with the manipulatives, interacting with the instructor, watching the video clips, and interacting with their peers in class.

Method

The videodiscs produced for the project have been used during the last two semesters in mathematics methods classes at our institution. We conducted interviews with 19 preservice teachers. These students were interviewed afterwards using an interview protocol developed by the project staff. The interview questions were directed toward the value of the videodiscs and what improvements could be made. The interviews sought students' reactions to using videodiscs in their methods classes, the benefits, and the drawbacks. They were asked to indicate what insights they gained that may be important to their future teaching and what they liked most and liked least about the videodisc experience. Students were asked to offer suggestions about improvements that could be made in the videodisc and in its use during instruction. They were asked, "Did the video help them to gain better understanding of teaching with the manipulative?" Their responses were recorded and clustered together to provide information with which to improve the discs and accompanying lessons.

All students were also asked to respond to four other questions on a 7-point scale (Extremely unlikely to extremely likely). These questions related to students' attitude about using the videodisc for their instruction and the effectiveness of it. The results are shown in the Appendix.

Results

The project staff read the interview data to determine some assertions that emerged (Erickson, 1986). Raw data were analyzed to compile common responses across the participants. The themes that emerged from the data clustered under the general assertion, "Videodiscs show the reality of the classroom when teaching mathematics with manipulatives and supports the theory learned from the college instructors." Under this overarching statement are three other themes: Use of manipulatives in actual classrooms, increased understanding about how to use manipulatives, and interactions between teachers and students.

Assertion: Videodiscs show the reality of the classroom when teaching mathematics with manipulatives and supports the theory learned from the college instructors.

Use of manipulatives in actual classrooms

A number of participants indicated that the videodiscs were a valuable way to see actual classrooms in action. College students can be given teaching techniques and classroom management techniques for using manipulatives, however, the videodiscs made the use of manipulatives become real. The interview data repeatedly revealed the students' reacting almost as if "seeing in action in real settings made me believe" as the following examplars indicate.

> "It's important to see what it's like in the real world which I think is different from the textbook."
>
> "Rather than just learning the theory surrounding the geoboards we saw the material actually being applied in the classrooms."
>
> "...but seeing the video let us see how it was applied in the classroom to real students and what real students might do with them and what teachers might be doing wrong."
>
> "Because the video showed how it's really applied--what students really do with them [geoboards] and how teachers actually use them.
>
> I think it is important to see the way kids actually use them and how teachers handle the lesson throughout the class time."
>
> "The different situations the teacher encountered was neat because it's hard to image that's going to actually happen in the classroom and all situations are different. Watching the video seemed to present those situations pretty well."

These examplars indicate the effect of experiencing the reality of the classroom on the students' perceptions about how to teach with manipulatives. The video segments helped students see actual applications and impressed upon the preservice students the benefits of this method of instruction. Viewing and discussing the video clips gave credibility to the value of manipulatives. The experience also added a dimension to the college classroom setting.whereby the university professor can follow-up the methodology with video segments showing teachers and students responding to the same lessons as this participant mentioned, "Despite the fact that it [the

videodisc] is impersonal, it shows visually what you [methods instructor] are saying verbally."

Increased understanding about how to use manipulatives

Another emerging theme as a consequence of viewing the videodiscs, is a sense of increased understanding and perhaps even confidence about using manipulatives for mathematics instruction. Ideas about manipulatives were clarified by viewing the video episodes. The increased understanding about how to use manipulatives is exemplified in these comments.

> "I didn't really know how to use them [manipulatives], but seeing the videodisc helped me understand what they are and how to use them."
>
> "The video clarified things for me and seeing the kids using them [geoboards] because now I understand them better."
>
> "I like the geoboards and I think they are great for the kids. I had never seen or understood what they were for a long time and seeing them used by the kids was neat."
>
> "I thought it was a good introduction how to use something with the classroom. You know, instead of just having someone stand up and *tell* you what to do, to be able to *see* it in use and get some ideas on how to use it. "

Some participants mentioned they felt they were getting experience which resulted in feelings of being more qualified and more excited and motivated to try teaching with them.

> "The kids interacting with the teacher, it was exciting and made me want to try teaching myself. Sort of a motivator."
>
> "It's sort of like getting experience. How do you teach experience?"
>
> "It makes you a little bit more qualified than other people already teaching who don't have experience with them."

If increased confidence and understanding about teaching with manipulatives are byproducts of this videodisc experience, perhaps these participants will use manipulatives for mathematics

instruction. This added component to the mathematics methods class may result in increased commitment to this way of teaching and may counteract some of the negative factors about manipulative use from the past. Follow-up studies when these students become student teachers and beginning teachers are being suggested by the project staff if further funding is awarded.

Interactions between students and teacher

Although not directly related to manipulative use, participants commented that observing student-teacher interactions was a beneficial aspect of the videodiscs. Video clips full of rich detail provided the reality of classroom situations. These comments indicate the value obtained from some experiences provided by the videodiscs.

> "Seeing the individual ways in which students react and work in different ways was important. Seeing how each student is different and how to focus on that student's individual needs is very useful."
>
> "The interacting between the teachers and the students was really great to see. We've learned about it all the time but you never see it actually done."
>
> "You can't get as much experience without seeing the actual class and the teacher interaction."

Besides talking about the value of seeing manipulatives in use and students and teachers interacting in classrooms, the preservice teachers also provided valuable general comments about the use of videodisc in methods class. They also provided specific comments that will help us to improve the lessons in which the videodiscs were used and the content of the disc. These latter comments have already helped us to adjust lessons so they will be more beneficial to the preservice teachers.

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Another cluster of responses related to various ways to improve the videodisc, the clips that were presented, the disc content, and the lessons in which the discs were used. Many of the comments regarding improvement to the lessons and the content of the videodisc relate to "executive" decisions made while planning the lessons and the disc development. There are many ways to put

lessons and discs together and offering alternative lessons and a variety of formats of disc content could be most beneficial.

Preservice teachers saw the value of the videodisc as a presentation tool. One said "The videodisc saved time because you could jump around from scene to scene. You didn't have to rewind or fast forward as you would with a tape. In this sense it was efficient."

Regarding the lessons as conceived and constructed and presented to the preservice teachers their responses reinforce some aspects and provide valuable comment for the improvement of other aspects of the lessons.

> ".....Great that we could follow along, and that we could participate with the video."
>
> "Too much material was crammed into the instruction time."
>
> "....things were done too quickly and that doesn't make it as much of a learning experience for us."

One student thought more should be provided because the videodisc lesson "....just shows how to use manipulatives not how to design the whole lesson plan around them." This information could be provided with videodisc scenes or through other means. Another student commented that "We weren't told what was going to happen." This problem has been reduced in a further lesson that we presented by the use of focus statements and questions before some of the clips. We have not discussed this lesson here. Several students reported that they would like to have some notes or handouts to take away to study and "help them remember this stuff."

Another cluster of responses was about the disc content and the classroom scenes on the disc. Many stated that the classroom scenes were too short and they couldn't always figure out what was going on in the brief exposure to the scene. Other students expressed concern about the content of the scenes. As one student said, "I don't mean to be picky ....". On the contrary, the evaluative feedback shows us what the student is seeing and reacting to in the disc scenes and the lessons.

> "....why is the teacher constantly working with one group of children?"

"....she is not paying attention to all the students."

"....didn't show enough of what was going on in the classroom."

"I'd like to see more examples in the classroom. I think you can't learn that from the books or the lecture."

Several preteachers said they would like the "opportunity to question the [elementary] teacher about what was happening." or "....why she did what she did." Perhaps this can be simulated in future discs with interviews with the teachers and the children. This was tried in an earlier tapeing session but it was not satisfactory. Now, with more experience we should try again.

Discussion

Videodisc-based resources have been effectively used for instruction in education and other professions. The research reported in this paper adds to knowledge about the effectiveness of these resources. The lessons which utilized the videodisc received positive comments from the preservice teachers in the classes as they learned about teaching and learning mathematics. Valuable comment was also received that will lead to improvement of the discs and lessons. The interviews and feedback from the preservice teachers indicated that the greatest benefit of the videodisc resource came from seeing manipulatives in actual use in classrooms. There "real" classroom scenes validate the "theory" presented by the instructors. Seeing the manipulatives and the variety of uses and seeing teacher/student interactions were reported by some preservice teachers as giving them more confidence that they could teach using manipulatives in their classrooms. The general tone of the feedback was positive and may indicate an increased likelyhood that these preservice teachers will use manipulatives when they teach.

Feedback also provided information that can be used to improve the disc content and the ways in which it can be used. Basically, the responses indicate that the video clips need to be surrounded with contextual support information to make them more menaingful and beneficial. This support information could overcome the problem due to short clips and the need for non-video materials to support the videodisc presented information.

The preservice teachers responces are directing further development. At the point at which we are in developing instructional resources for mathematics methods courses, we have had our ideas and visions reinforced and advanced by the investigation reported in this paper.

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